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ULTRASOUND PROPERTY OF ARTICULAR CARTILAGE IN SEVERE VARUS KNEE OSTEOARTHRITIS

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Aim of Study. To evaluate degenerated and seemingly normal cartilage in severe varus knee OA, the ultrasound indices of stiffness, surface irregularity and thickness were measured during total knee arthroplasty. Methods. The three indices of ultrasound were measured in twenty knees of twenty subjects, 2 males and 18 females, mean age of 76 years (68 to 83), who underwent the surgery. Five hundred and ten points measured were classified into seven sites; site 3: femoral lateral condyle (anterior), site 4: femoral lateral condyle (posterior), site 7: femoral medial condyle, site 9: lateral tibial plateau (center), site 10: lateral tibial plateau (under the meniscus), site 11: medial tibial plateau (anterior), and site 12: medial tibial plateau (posterior). The points were also evaluated macroscopically using the grading of International Cartilage Repair Society (ICRS grade). Results. At site 3, 4, 9 and 10, grade-0 cartilage shared 51%, 65%, 2% and 80% respectively and at site 7, 11 and 12, it shared 0%. ANOVA revealed that the index of stiffness in grade-0 cartilage was significantly higher (stiffer) than those in grade-1, -2 or -3 ($p<0.001$). The index of grade-0 cartilage of the site 4 was higher than that of site 3 or 10 ($p<0.01$). Index of surface irregularity of grade-1 and -2 cartilage was higher (more irregular) than that of grade-0 ($p<0.01$). The index of thickness of grade-1 was higher (thicker) than that of grade-0 ($p<0.05$) and that of grade-3 was lower (thinner) than those of grade-0, -1, or -2 ($p<0.001$). Conclusions. Because ultrasound is related to the extracellular matrix collagen and its fibrillar network, the index of stiffness indicates that the collagen network in severe varus knee OA has already deteriorated in medial component but is maintained in the lateral. Site-specific difference in the index of grade-0 in the lateral component suggests that early events may occur in the surface of seemingly normal cartilage. In order to prevent the progression of OA, therefore, collagen network damage should be detected in early stage of osteoarthritis.

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ABNORMAL ANKLE SCINTIGRAPHY IN A COHORT WITH KNEE OSTEOARTHRTIS

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Aim: Ankle arthritis is considered a rare entity and typically a sequela of injury. The goal of this study was to evaluate the prevalence of ankle abnormalities in a cohort with knee OA, using bone scintigraphy, a sensitive method for detecting metabolic abnormalities of joints. We hypothesized that factors in addition to overt injury could be risk factors for ankle OA, including knee OA or malalignment of the knee.
Methods: Participants in the Prediction of Osteoarthritis Progression (POP) study (n=159; 118 female, 41 male; mean age 64 years), met ACR criteria for knee OA and had radiographic OA (Kellgren-Lawrence grades 1-3) in at least one knee. Late phase uptake of technetium-99m methylene diphosphonate by the ankle or forefoot (at 2.5 hours post injection) was assessed as normal or increased on a whole body scan. Ankle symptoms were assessed from a menu of "joints that bothered you in the past year". Self reported ankle or foot injury was recorded in a general medical history. Knee alignment was measured from a long-limb radiograph. Logistic regression modeling was performed with JMP software (SAS, Cary, NC).
Results: One or both ankles bothered 23% of participants during the previous year. Scintigraphic abnormality of one or both ankles occurred in 23%; this figure rose to 50% when either foot or ankle uptake was considered. A symptomatic ankle was 1.9 times more likely to have a positive bone scan. Table 1 depicts the concordance of symptoms and abnormalities by bone scintigraphy for the n=318 assessed ankles.

Table 1

	Negative Bone Scan	Positive Bone Scan
No Ankle Symptoms	#220 (69%)	#42 (13%)
Yes Ankle Symptoms	#39 (12%)	#17 (5%)

Surgery or ankle injury was reported for 4% of ankles. A larger proportion of ankles with scintigraphic abnormalities had a history of associated ankle surgery or injury (12%), compared with those without ankle scintigraphic abnormalities (3%), p=0.005. In multivariate logistic models controlling for the other variables, ankle scintigraphic abnormalities were associated with ankle injury or surgery (p=0.04) and ankle symptoms (p=0.02), but not body mass index. The degree of knee malalignment was associated with ankle symptoms (p=0.05), but not ankle scintigraphic abnormalities.
Conclusions: The literature related to the prevalence of symptomatic ankle OA is limited, but available references are in general agreement that ankle OA is rare, occurring at a rate of $<$ 1%, with a frequency nine times less than that of knee or hip OA. Our study demonstrates that metabolic abnormalities of the ankle and forefoot are common in this cohort with knee OA. Although a history of ankle injury or surgery was fourfold more common for ankles with scintigraphic abnormalities, these risk factors were reported by only 12% of participants with abnormal ankle bone scans, suggesting that additional factors may contribute to ankle pathology in a knee OA cohort. Longitudinal investigation of this cohort is ongoing to determine if an abnormality of the ankle by bone scintigraphy is predictive of subsequent radiographic OA, as has been found for knee OA.

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KELLGREN-LAWRENCE SCORES AND ARTHROSCOPIC FINDINGS IN THE DEGENERATIVE KNEE

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Introduction: Other studies have shown that the K-L radiographic score can differentiate the severity of osteoarthritis when compared to MRI findings. However, the correlation of the K-L score with arthroscopic findings has been limited. The purpose of this study is to determine if differences in arthroscopic findings exist between knees with Grade 3 and Grade 4 K-L scores.
Methods: Tibiofemoral knee osteoarthritis was graded according to the Kellgren-Lawrence (K-L) scale in 89 knees presenting for arthroscopic treatment of osteoarthritis of the knee. The study group consisted of 55 males and 34 females with an average age of 55 (range 37 to 88) years. There was no age difference between gender. All radiographs were examined independently by two orthopedic surgeons and arthroscopic data was collected prospectively and recorded by orthopedic surgeon. At surgery, the surgeon was unaware of the documented K=L score.
Results: On review of radiographs, 5 knees had a Grade 2 K-

L scores, 47 had Grade 3 K-L scores, and 37 had Grade 4 K-L scores. All knees had documented osteophytes and sclerosis on radiographs. 87 knees had joint space narrowing. At arthroscopy, ipsilateral tibial and femoral lesions in one compartment were noted in 49 knees, and ipsilateral tibial and femoral lesions in both the medial and lateral compartments were noted in 17 knees. Meniscal pathology was present in 78 knees (37 had medial and lateral pathology). In comparing knees with Grade 3 and 4 K-L scores, there was no difference in age. There was a difference between K-L Grade 3 and 4 and gender, with more males having a Grade 4 K-L score (p=0.001). There was a difference between the number of cartilage surfaces with Grade 3 or 4 Outerbridge chondral damage, and K-L Grade 3 and K-L Grade 4 knees. Knees with Grade 4 K-L had more Grade 3 or 4 Outerbridge lesions on 3 or 4 tibial and femoral surfaces than Grade 3 K-L knees (p=0.001). Grade 4 K-L knees also had significantly more ipsilateral chondral lesions than Grade 3 K-L knees (p=0.000). There was a significant difference between Grade 3 and 4 K-L knees and the presence of meniscal pathology(p=0.032). However, of those knees with meniscal pathology, the presence of both medial and lateral meniscal pathology was not different between K-L Grade 3 and K-L Grade 4.(p=0.49)

Conclusion: In this study population, a difference was found in gender, chondral degeneration, and meniscal pathology between Grade 3 K-L and Grade 4 K-L knees. The K-L scale can differentiate between moderate and severe osteoarthritis.

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AUTOMATED SIMULTANEOUS 3D SEGMENTATION OF MULTIPLE CARTILAGE SURFACES USING OPTIMAL GRAPH SEARCHING ON MRI IMAGES

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Aim of the study: To evaluate a novel fully automated 3D graph searching cartilage segmentation algorithm on images of thin congruent talus cartilage layers and compare quantitative measurements against an independent standard.

Methods: 8 cadaveric human ankles were imaged at 1.5T using an isotropic 3D T1 weighted FLASH sequence with water excitation; resolution 0.3mm^3, scan time 17mins 14secs. Each data set was interpolated to 0.15mm^3 and segmented using the automated 3D graph searching algorithm. Two independent standards were used for comparison; firstly 50 randomly selected slices from the 8 MR volumes were manually segmented. Coronal and sagittal slices were used to assess the inherently 3D segmentation against 2D manual segmentation and the positioning errors of the automated segmentation compared to the manual segmentation were calculated for each slice. Secondly, following MRI each ankle was disarticulated and imaged using a previously reported high resolution stereophotography method; mean cartilage thickness and volume were measured for comparison to MR measurements

To assess reproducibility of the automated segmentation a further 5 independent initializations of the automated segmentation algorithm were performed on each of the 8 image sets. The position and size of the initializing spheres were varied and the mean difference ± S.D. of cartilage thickness compared to the original automated segmentation was calculated

Results: The average automated 3D computation time was 4mins 30secs. The mean talar cartilage thickness from automated segmentation was 1.16 ± 0.1mm. The mean talar cartilage thickness from stereophotography measurements was 1.21 ± 0.17mm. Mean talar cartilage volume from automated segmentation was 2.61 ± 0.34ml and the mean cartilage volume from stereophotography measurements was 2.62 ± 0.49ml.

The RMS surface positioning errors of the automated computer segmentation compared to expert manual segmentation showed subvoxel accuracy and were 0.03 ± 0.01mm and 0.04 ± 0.01mm for the bone and cartilage surfaces, respectively.

For the repeated initializations the mean difference of mean thickness compared to the original automated segmentation was 0.05 ± 0.04mm; differences were unbiased.

Conclusions: The reported technique has achieved highly accurate, rapid, automated segmentation of thin, congruent talar cartilage, including the highly curved regions over the talar shoulders and compares favourably to independent standards. This approach addresses a number of the existing challenges associated with traditional techniques for segmentating cartilage sensitive MR images which are not suitable for fast automated segmentation. This new technique has considerable potential for future use in a clinical setting and large clinical trials.

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MAGNETIC RESONANCE AND COMPUTED TOMOGRAPHY OF ARTICULAR CARTILAGE, AND SUBCHONDRAL BONE CHANGES IN A NON-HUMAN PRIMATE MODEL OF OSTEOARTHRITIS

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Aim: To determine the utility of non-invasive imaging techniques for early detection andlongitudinal progression of age-related degenerative joint disease in a non-human primate model for spontaneous osteoarthritis.

Background: OA develops spontaneously in rhesus monkeys, and the study of medial compartment disease in the species has provided some model for studying naturally occurring OA. Both the prevalence and severity of knee OA increase with age in this species.

Justification for animal use: Because the etiology of OA is poorly understood and the disease progress slowly until significant joint impairment has occurred; designing human studies to understand the pathophysiology of the disease has been almost impossible. The use of murine and canine animal models to study OA, although useful, have generated much skepticism as to how well these models can truly mimic the disease in humans. In particular, the study of therapeutic effects in these disease models are often uncertain.

The rheses macaque is the most suitable animal model for comparative studies of OA because the non-human primate: 1) has a close biological relationship to humans; 2) is bipedal. 3) spontaneously develops age-related OA, in a similar distribution to the disease found in humans.

Methods: Specimens were gathered through the National Institutes of Health Tissue Bank. All specimens were collected postmortem and the excised limbs with intact joint capsule stored in buffered formalin.

The fixed joints were imaged using an Imtek MicroCat-II x-ray computed tomography (CT) system. Segmentation of the images was obtained to determine the bone mineral density. The micro-MRI scanning was done on a 4.7 Tesla Oxford Instruments 40 cm horizontal bore super conducting magnet. All images were analyzed using the Amira 3-D visualization software

Results: The findings reported are from the analysis of knee joints from animals, age ranging from: 4 years, 8 years, 14 years, 25 years, 36 years and 45 years of age.

The micro-CT images reveal a progressive decrease in mineralization of the subchondral bone, and disintegration of the nor-